

IBM's Smarter Cities Challenge

Milwaukee

Report





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1. Executive summary

The City of Milwaukee is one of 24 cities around the world chosen to receive a grant from IBM in 2011 as part of IBM's Corporate Citizenship efforts to build a Smarter Planet™. IBM's Smarter Cities™ Challenge aims to contribute to the improvement of high-potential cities around the world by sending teams of IBM experts to work with cities to analyze urban concerns such as public safety, budgeting and resource allocation, and the environment and make recommendations. During three weeks in June 2011, a team of five IBMers worked with the City of Milwaukee to deliver recommendations around the theme of *Smarter Cities Feed Themselves*.

The Opportunity

To become a Smarter City, a city needs to identify the critical issues that improve the quality of life for its residents by:

1. Creating sustained economic growth and job creation;
2. Limiting and/or addressing key inhibitors to that growth;
3. Identifying cost-effective, easily implemented solutions;
4. Obtaining broad community support.

In the view of the IBM team, urban agriculture and aquaponics have the potential to address these issues and make Milwaukee more economically viable while engaging the community's support. With clear measurable goals and objectives, these recommendations are attainable and affordable. In the report, specific steps are identified to foster the growth of aquaponics in Milwaukee:

- Establish an Urban Agriculture and Aquaponics Council, based on the successful model of the Milwaukee Water Council to advance the science and business success of the industry through the collaboration and sharing of knowledge, innovation, and technology by for-profit, nonprofit and public sector stakeholders

- Establish an Aquaponics Innovation Center to:
 - Build upon technology transfer and skills development by area universities and K-12 education
 - Evaluate new aquaponics technologies
 - Support aquaponics business development and maturity by analyzing and documenting best practices and economic impact using research methodologies and business metrics
 - Act as a virtual and physical incubator for new companies
 - Investigate operational impacts on aquaponics system sustainability
 - Perform public outreach to tell the story of the aquaponics industry
- Develop a market analysis of aquaponics production, supply chain expansion and market opportunity to guide industry expansion
- Expand the City's Office of Environmental Sustainability to serve as the industry advocate for urban agriculture and aquaponics for all City endeavors.

Conclusion

The City of Milwaukee has the base investment and attributes needed to become a smarter city that feeds itself. Building upon the maturing models of aquaponics, Milwaukee has the potential to influence the world food supply. Aquaponics being a freshwater closed-loop system of fish and greens production, it requires no significant water demands beyond initial start-up. With encouragement and through careful pursuit of its aims, Milwaukee can lead the way as a smarter city and water steward to help the world feed itself.

2. Introduction

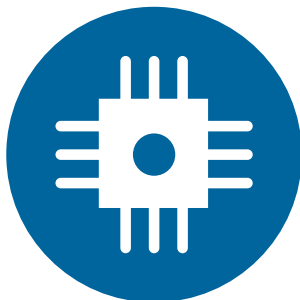
A. The Smarter Cities Challenge

By 2050, cities will be home to more than two thirds of the world's population. They already wield more economic power and have access to more advanced technological capabilities than ever before. Simultaneously, cities are struggling with a wide range of challenges and threats to sustainability in their core support and governance systems, including transport, water, energy, communications, healthcare and social services.

Meanwhile, trillions of digital devices, connected through the Internet, are producing a vast ocean of data. All of this information – from the flow of markets to the pulse of societies – can be turned into knowledge because we now have the computational power and advanced analytics to make sense of it. With this knowledge, cities could reduce costs, cut waste, and improve efficiency, productivity and quality of life for their citizens. In the face of the mammoth challenges of economic crisis and increased demand for services, ample opportunities still exist for the development of innovative solutions.

In November 2008, IBM initiated a discussion on how the planet is becoming “smarter”. By this it meant that intelligence is becoming infused into the systems and processes that make the world work – into things no one would recognize as computers: cars, appliances, roadways, power grids, clothes, even natural systems such as agriculture and waterways. By creating more *instrumented*, *interconnected* and *intelligent* systems, citizens and policymakers can harvest new trends and insights from data, providing the basis for more informed decisions.

A Smarter City uses technology to transform its core systems and optimize finite resources. Since cities grapple on a daily basis with the interaction of water, transportation, energy, public safety and many other systems, IBM is committed to a vision of Smarter Cities as a vital component of building a Smarter Planet. At the highest levels of maturity, a Smarter City is a knowledge-based system that provides real-time insights to stakeholders, and enables decision-makers to manage the city's subsystems proactively. Effective information management is at the heart of this capability, and integration and analytics are the key enablers.



Instrumented

We can measure, sense and see the condition of practically everything.



Interconnected

People, systems and objects can communicate and interact with each other in entirely new ways.



Intelligent

We can analyze and derive insight from large and diverse sources of information, to predict and respond better to change.

Figure 1

Intelligence is being infused into the way the world works

As IBM aligns its citizenship efforts with the goal of building a Smarter Planet, we realize that city leaders around the world face increasing economic and societal pressures. Given the increased demand for services, they have to deliver new solutions ever more rapidly.

With this in mind, IBM Corporate Citizenship has launched the Smarter Cities Challenge to help 100 cities around the world over a three-year period become smarter through grants of IBM talent. The City of Milwaukee was selected through a competitive process as one of 24 cities to be awarded a Smarter Cities Challenge grant in 2011.

During a three-week period in June of 2011, a team of five IBMers worked in the City of Milwaukee to deliver recommendations around key issues to Mayor Tom Barrett.

B. The Challenge

The city of Milwaukee has a rich history. In the past, its hard work and entrepreneurial spirit gave rise to local industries based on fur trapping, manufacturing, and food and beverage production. The city also has immutable ties to water. Milwaukee's name has Native American origins meaning "gathering place near the waters", and its location at the confluence of three rivers, the Milwaukee, the Menomonee and the Kinnickinnic, is symbolic of its ties to the land, fresh water, and the population/industries that uniquely identify with the city.

Perhaps more importantly, a spirit of cooperation and pride forms the bedrock for its residents and communities, industries and City government.

However, like many cities in today's difficult economic landscape, Milwaukee faces many challenges. It is seeking to reinvent itself, to move beyond the slogan of "Milwaukee Feeds and Supplies the World" to support a new mission that will guide the City as it moves through this new century. This is captured in Milwaukee's Smarter Cities Challenge, *Smarter Cities Feed Themselves*.



"Milwaukee Feeds and Supplies the World"

Image kindly supplied by the City of Milwaukee and is used with permission

Source: <http://city.milwaukee.gov/Neighborhoodposters.htm>

This study was proposed by Milwaukee Mayor Tom Barrett with the full support of many city stakeholders, both for-profit and not-for-profit. It seeks to understand how, in the context of urban agriculture, the aquaponics industry can help a smarter city feed itself by having a positive impact not only on a city's food supply, but also on the social fabric that supports a city's health, jobs, education and public safety.

The study makes recommendations to help Milwaukee create an environment within its urban agriculture landscape that will foster the growth of the aquaponics industry and advance Milwaukee's identity as a global water leader and as a city that feeds itself.

Milwaukee Food Deserts

A food desert is a concentrated area with little access to affordable and nutritious foods such as fruits, vegetables, and fresh meats. In an urban setting, a food desert is a large cluster of blocks without access to a traditional grocery store. The USDA identifies 20 Milwaukee census tracts as "food deserts". In Milwaukee, food deserts are found on broad areas of the lower socio-economic neighborhoods of the West and the near North Sides, a result of trends in retailing where supermarkets have left the inner city due to safety fears and lower margin stores (UW-Milwaukee Department of Architecture and Urban Planning). What remains is often fast-food outlets and convenience stores with less healthy packaged and processed foods.

Across the U.S. there are generally more than three times as many supermarkets in wealthier neighborhoods than in poorer areas. Even when supermarkets are found in low Socio-Economic Status (SES) neighborhoods, prices tend to be substantially higher. To compound the food desert paradox, fast food outlets are disproportionately located in low SES neighborhoods, and are 2.5 times more likely to be found in lower income areas than higher income areas.

Research has found food desert residents to be at risk from a variety of health problems. Diet has a direct link to obesity, diabetes and other chronic illnesses. In Wisconsin, Milwaukee is ranked very high for obesity levels and diet-related disease. In its poorer sections, 34 percent of residents experience obesity, levels much higher than the median U.S. or state levels.

Cities can tackle the challenges of food deserts and feed themselves by augmenting existing food distribution channels with healthy food grown locally by both for-profit and non-profit organizations (NPOs). Non-profit sources have established themselves throughout the Milwaukee metropolitan area and offer healthy food, grown free from chemicals/pesticides and without significant transportation costs. They also provide related community education, skills development and social organization in economically deprived areas in need of revitalization.

The NPOs are a vital source of hope and purpose in communities that have seen the worst of our economic downturn. If an organization that feeds the local community can become self-sustaining or even profitable, the aquaponics industry can be expanded, offering social and economic benefits in the form of new jobs and related economic stimulus in those areas of cities where jobs are most needed.

New jobs in the community not only provide those skills directly related to providing healthy food for the community, but also new workplace skills that further enhance personal and community commitment and responsibility – success that others can build upon.

Milwaukee's renowned food producing NPOs have been in operation since the 1990s and have received national recognition. They currently collaborate with the for-profit food businesses in the community and are sources of valuable information that can be tapped to understand how similar organizations can become profitable. If successful, Milwaukee can be a city that feeds itself, leveraging and furthering its status in the UN Global Compact Cities Programme by connecting urban food production to water.

C. Approach

Over the three week Smarter Cities Challenge, the IBM team worked with and received outstanding support from City leaders, community organizations, local businesses, the University of Wisconsin-Milwaukee, its Great Lakes Water Institute, and the Milwaukee Water Council. Meeting with thought leaders of these different constituents helped the team gain a clearer understanding of the strength of resources in Milwaukee and the decision for these groups to work together to “feed” Milwaukee. The following activities have helped the team frame the challenges facing Milwaukee:

- Discussions with Mayor Tom Barrett, Department of City Development (DCD) Commissioner Rocky Marcoux, and Senior Economic Development Specialist for the Redevelopment Authority, Dan Casanova
- Tours of and discussions with Sweet Water Organics, Growing Power, Walnut Way, and Natural Green Farms
- Interviews with City officials, department heads, school officials, community leaders, non-profit organizations, representatives from Milwaukee companies, and other leaders in the city
- Analysis of background materials on Milwaukee, urban agriculture and aquaponics
- Review of the City's economic development strategies, notably the Menomonee Valley and Century City in the 30th Street Corridor

The IBM team focused on the concept of a smarter city feeding itself. It has looked at aquaponics in the larger context of urban agriculture, in an attempt to highlight key initiatives where the City is fostering the growth of aquaponics. The team also identified tactical and long term recommendations to help the City leverage its leadership in aquaponics and fresh water management.

3. Overall Findings and Themes

A. Introduction

As the IBM team met with many stakeholders throughout the city and region, several themes began to emerge, revealing that common purpose closely binds the City and its stakeholders.

The science of aquaponics, with its innovative techniques and promise to address some of the world's food supply issues, is compelling. Business, academic and community leaders in Milwaukee have rallied to support this nascent industry. Volunteers come from across the community, including K-12 and university students, bringing varied skills (architecture, business, urban planning, agriculture and marketing).

We have noted that the compelling social value of aquaponics and its interaction with the community inspires much passion and exuberance. This enthusiasm and community engagement is a strength of the Milwaukee aquaponics industry and should be fostered and encouraged, but it must be balanced to ensure that the goal of sustainable production is achieved.

Three themes emerged during this analysis:

Industry Development is important because it provides jobs and drives commerce. Businesses have to innovate to be competitive. This innovation can be shared to help build the community and add to Milwaukee's identity.

Community Transformation appears through neighborhood organizations and local non-profits as they leverage their skills to build a stronger social fabric by developing and strengthening areas of need and support. The communities involved in urban agriculture provide healthy food, related education, leadership, hope and more.

Milwaukee Identity extends the city's established leadership in water beyond its boundaries to place itself in a global context. When a business in Europe or a thought leader in Asia attempts to address challenges in water and sustainable food production, Milwaukee should come to mind as a world leader in these areas.

These three themes, focusing on Industry Development, Community Transformation, and Milwaukee Identity are graphically depicted in Figure 2 and are described in the following sections. They underlie our observations of the city and the summary recommendations in this report. The themes interweave to provide the foundation for the discussion on how a vibrant, globally recognized Milwaukee can help smarter cities around the world feed themselves.

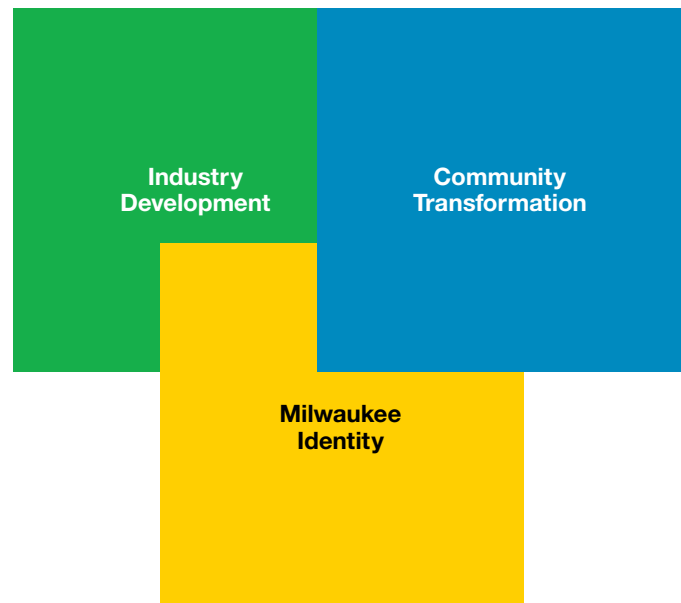


Figure 2
Feeding a Smarter City: Three Major Themes

B. Industry Development

Milwaukee has an entrepreneurial history of creating homegrown industries that have become major businesses in areas like mining and manufacturing (Rexnord, Bucyrus, P&H Mining Equipment (Harnischfeger)) and brewing (Miller-Coors, Pabst, Schlitz, Blatz). Businesses that defined industries emerged in the city and then became the catalysts that established and economically supported Milwaukee neighborhoods. These industries formed Milwaukee's early identity in "feeding and supplying the world".

The combination of this “Regional DNA” with a strong community spirit of “working collaboratively to get things done”, has contributed to Milwaukee’s successful economic development and its unique and distinctive identity.

The economic downturn in the latter part of the twentieth century and the beginning of this century, dramatically affected the landscape of Milwaukee and other American cities, with forced company consolidations, business closures, and increased unemployment. Along with other cities across the world, Milwaukee is now exploring innovative ways to counteract these dramatic effects on quality of life, through economic development and workforce enablement in the city’s neighborhoods.

In this challenging environment, the City is working in tandem with its business leaders, neighborhoods and academic and research communities, to utilize its core strengths. It is seeking to revitalize industry within the metropolitan region, in order to create jobs, improve public safety, restore neighborhoods, and advance overall quality of life. This Smarter Cities Challenge study is one result, focusing on a prime economic opportunity that is based on Milwaukee’s identity around fresh water and its vital association with food production.

The Water Council is establishing the Milwaukee region as the global water hub for freshwater research, economic development and education, working with major water-related companies and academic research institutions in the area. Aquaponics, the symbiotic combination of aquaculture and hydroponics, is a natural product of Milwaukee’s successes in urban agriculture and water.

Milwaukee’s strengths to support its leadership in this area lie in urban agriculture, water-related skills, its available resources (industrial sites and buildings, workforce), and a supportive city infrastructure. These factors create an ideal opportunity to evaluate and build a viable aquaponics industry. They are also an ideal vehicle for validating the City model of City-supported industry that can positively impact economic development and community transformation.

Lastly, while Milwaukee provides an abundant source of fresh water, a plentiful water source is not a prerequisite for a successful aquaponics system. In fact, as a closed loop system, the only water an aquaponics system needs is that required to make up for evaporative losses. As a world example of global fresh water, Milwaukee, in a successful association with aquaponics, can serve as the model for stewardship of limited water resources and for the replication of this solution elsewhere in the United States and the world.

Urban Agriculture

Urban agriculture is the production of food within the boundaries of a city. This generally refers to agricultural activity in small areas such as empty lots, production gardens, community gardens, and private residences. Not only are fruits and vegetables included, but Milwaukee recently accommodated chickens and honey production in its city zoning. The goal of urban agriculture is to create sustainable local food supplies that reduce costs between farm and fork. To achieve greater production, cities must integrate farming practices into urban governance, environmental, social and economic systems. The opportunity to extend the urban food supply chain to expand production, processing and distribution can lead to job growth, as well as healthier communities.

Urban agriculture has taken root not only in Milwaukee, but also across the United States, with major initiatives in cities including Cleveland, Detroit, Seattle, Madison, Minneapolis, Philadelphia, Portland, and Baltimore. Several factors have contributed to the increasing popularity of urban agriculture in the past decade:

- Demand for healthy food alternatives in lower income neighborhoods.
- Under-utilized land that can be made available for urban agriculture.
- Increased willingness of cities to modify zoning regulations.
- Unintended environmental and health impacts of food grown thousands of miles away.

The benefits of urban agriculture can be seen through multiple lenses:

Safety

- Consumers depend on a global web of growers, fisheries, packers, shippers, manufacturers, retailers as well as government and industry bodies. However, many countries have inconsistent standards for quality, process and accountability. In the U.S. alone, 76 million cases of food-borne illnesses occur each year. Imports account for nearly 60 percent of the fruits and vegetables we consume, and 75 percent of the seafood. Yet only one percent of these foods are inspected before they enter the U.S.
- Consumers are hungrier than ever for information about their food. They are better informed about nutrition and more aware of the environmental and societal impacts of everything they buy. According to an IBM Institute for Business Value survey, two out of every five U.S. and U.K. consumers say safety concerns dictate what food they will or will not purchase.

Waste

- 30 percent of the food purchased in developed nations ends up going to waste.
- Supply chain inefficiencies lose consumer product firms and retailers \$40 billion annually, or 3.5 percent of their sales.

Environment

- Sixty years ago, we could create a calorie of food with less than half a calorie of fossil fuel. Today, 10 calories of fossil fuel are needed to produce a single calorie of modern supermarket food.
- Rising fuel costs are making it increasingly difficult to get enough food to populations now dependent on distant producers.
- Produce grown closer to home racks up fewer petroleum-based transport miles than foods trucked cross country to your table.
- The average distance traveled for food in the U.S. is estimated at 1,500 miles.
- Less need for packaging, protection and storage of food.

Health

- Direct access to nutritious food for urban populations.
- Greater availability of fresh, perishable food.

Sustainability

- Reintroduction of green space.
- Greater proximity to services, including waste-treatment facilities.
- Waste-recycling and re-use possibilities.
- Water runoff reduction and sewage treatment.

Economics

- Increased jobs and incomes related to agricultural output.
- Non-market access to food for poor consumers. The World Food Summit of 1966 defined food security: "When all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life." In Wisconsin, about 8.9 percent of households are "food insecure" and 2.7 percent have "very low" food security.
- Expansion of the city's economic base through production, processing, packaging and marketing.

Aquaponics

Aquaponics is a sustainable form of closed-loop agriculture that combines two techniques: hydroponics and aquaculture. Hydroponics is a water-based growing method to raise plants without soil. Plants are cultivated instead with their roots directly in contact with water, allowing them to absorb pH-balanced nutrients in a more efficient manner to achieve faster, better growth. Aquaculture is the breeding, raising and harvesting of fish and other water-based life in water environments, often closely controlled.

A closed loop aquaponics system is based on multiple tanks and pumps circulating to form a nutrient cycle. By-products generated by the fish become a highly effective fertilizer; “Beneficial Bacteria” convert the ammonia from fish waste into nitrates that nutrify crops through waterborne roots. In the final part of the closed loop cycle, plant roots purify the water, which is then aerated and returned to the fish tanks.

Benefits of aquaponic systems in urban agriculture:

- Produce higher crop yields more quickly than traditional agriculture, through the constant flow of nutrients to plants and intensive plant spacing.
- Extremely water-efficient through continuous water reuse and recycling.
- Achievable within relative small spaces like warehouses and community gardens.

Challenges in Aquaponics

Aquaponic systems, while in their infancy, have thousands of variations on their basic formula, with many potential drawbacks. Mechanical and water quality failure can severely impair a system's ability to produce crops. Systems are subject to dozens of technical breakdowns whether electrical, bacterial, or biological throughout the structure. A pump or electrical source may fail with the loss of the entire crop of fish overnight, and the collapse of the whole system.

A sustainable agriculture

Aquaponics, an inventive form of closed-system agriculture, combines hydroponics and aquaculture – water-based gardening and fish cultivation.

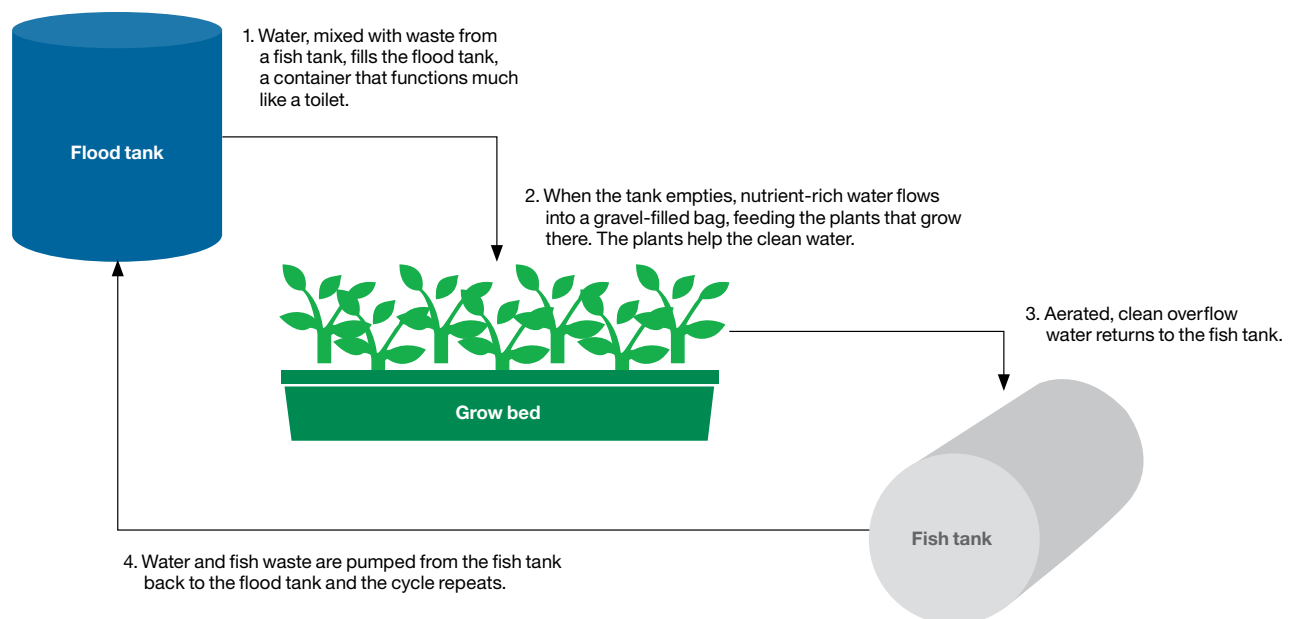


Figure 3

Aquaponics: a sustainable agriculture

Source: Travis W. Hughey, New York Times

C. Community Transformation

A prominent theme in the team's meetings and discussions has been the transformative effect that urban agriculture, and more specifically aquaponics, can have on a community. Each community organization has spoken with passion of the benefits they have seen first hand from the work being performed in their respective areas. Indeed, stories of the beneficial effects on schools and students, neighborhoods, families, health, and the potential for job creation were related with exuberance and dominated most conversations.

Aquaponics and urban agriculture can clearly play a role in addressing the challenging issues of food deserts and the availability of healthier food choices within a city. The problems faced by Milwaukee and other cities can be addressed by the right infrastructure (distribution, retail locations and so forth) to support the industry. Scale of overall production, whether in one location or many, is key, as is the development of a consistent and reliable supply chain to function in this urban model. The team observed a wide range of urban agricultural models, including home gardening, neighborhood gardens, larger non-profit urban farms and burgeoning aquaponics efforts, both non-profit and commercial.

Urban agriculture is acknowledged as a force for renewal in neighborhoods and an indicator of community "resilience" ("Farming Inside Cities: Entrepreneurial Urban Agriculture in the United States", Jerry Kaufman and Martin Bailkey, 2000, Lincoln Institute of Land Policy). While many cities and communities are already embracing urban agriculture as a mechanism to "feed themselves" and enable urban renewal, Milwaukee is fortunate to have committed and established organizations, whose founders have vision and eminence. They are true leaders in the sector. The good work being done by these visionaries, and the national and international recognition they have garnered for their organizations is a strength for Milwaukee, significantly furthering the City's identity as a sustainability champion.

Will Allen is an example of the power of public recognition that he and others are bringing to Milwaukee. As the founder of Growing Power, he has been recognized by the McArthur Foundation and Time Magazine, with continued press mention for his associations with the Clintons, Michelle Obama, and Oprah Winfrey. This recognition can be leveraged by the City to focus attention on the importance of urban agriculture and aquaponics.

As a "gathering place near the water", Milwaukee exemplifies the willingness of its community organizations to "gather" and assemble to share information and help one another. This spirit of cooperation enables "cross-pollination" of ideas and experiences; Walnut Way helped forge the Food Council, and Sweet Water Organics was inspired by its involvement with Growing Power. This organic information-sharing is a clear strength of the city.



Source: Sweet Water Foundation
<http://www.flickr.com/photos/sweetwaterfoundation>

City support is a key enabler for the development of aquaponics as a successful and replicable model. Fortunately, the support from both the people and the City of Milwaukee is strong. In all of their interviews, it has been clear that City leadership and staff have embraced urban agriculture and specifically aquaponics as a potential contributor to the community's revitalization. In difficult economic times, cities must make difficult choices with the limited resources available. Recent funding of urban agricultural projects within the city visibly demonstrates their support.

Aquaponics as a new approach in urban agriculture is clearly compelling to those who are exposed to it, particularly to youth. Aquaponics provides an opportunity to teach science, technology, engineering and mathematics (STEM) in a real world application. Students who are involved with aquaponics organizations such as Sweet Water Organics develop an enhanced sense of purpose and connection, with resulting benefits such as improved school attendance and achievement and an awareness of healthier food choices.

When visiting Sweet Water Foundation and Growing Power, the team was taken with the passion of the volunteers; it is difficult not to be drawn to both the nobility of the goals and the science of the actual operation. Nonetheless, results are anecdotal at this point, with little objective data. Measuring the quantifiable impact of these urban aquaponics examples would serve to validate continued support and provide the justification to use them as a model for other cities in their revitalization efforts.

D. Milwaukee Identity

There are several factors that contribute to Milwaukee's identity. It has a long history of leadership in water and water management, sustainability and entrepreneurship.

A Leader in Water Management

Milwaukee has often been referred to as a great place near a great lake. Lake Michigan and the abundance of the valuable resource of water has always been a key factor in the identity of Milwaukee. In 2009, the Milwaukee Water Council was proudly inducted into the United Nations Global Compact Cities Programme, for its expertise in freshwater technology.

Milwaukee's Water Council has leveraged the leadership of the University of Wisconsin-Milwaukee and the Freshwater Institute to bring together companies in the water industry and to showcase Milwaukee's leadership in this area. The reputation and respect that Milwaukee has achieved around water has continued to bring industry and academic interest to the city. It remains a big part of what makes the city special.

A Leader in Sustainability

Milwaukee's founding spirit of cooperation and pride has contributed positively to the city in the area of sustainability. City government, industry and community organizations have successfully identified ways to use and reuse resources responsibly. This applies not only to natural resources such as water, food, land and energy, but also to additional resources such as workforce and buildings in the city.

The City has won awards for its work on brownfield projects, most notably the development of the Menomonee valley (Phoenix Awards). It has also received recognition for its leadership in stormwater management in conjunction with the Milwaukee Metropolitan Sewerage District.

Milwaukee has proved to be very successful in urban agriculture and continues to foster the development of new organizations focused in this area. As we have noted, nationally recognized organizations such as Growing Power, Walnut Way and Sweet Water Organics to name a few, have provided strong examples within the community of how a smarter city feeds itself. They show how a city can become more sustainable through the positive impact of creating healthier food. They provide the city not just with food, but with the accompanying benefits to health, jobs, education and public safety, by encouraging a community of citizens that respects resources.

A Leader in Entrepreneurship

The combination of Milwaukee's heavy manufacturing history and a high concentration of motivated individuals has resulted in the creation of many extremely successful local companies. The City has supported the growth of numerous homegrown businesses and is proud of their success and the contributions they make. According to Rocky Marcoux, what makes Milwaukee special is that "Many of the companies that are successful in Milwaukee started in garages and have grown into global industry leaders."

Milwaukee's leadership in urban aquaponics is simply a reiteration of Milwaukee's traditional entrepreneurial leadership.

4. Recommendations

The City can play a significant role in enabling innovation in aquaponics to enhance its efficiency further in order to facilitate replication within Milwaukee, the region, and beyond. While Milwaukee has the opportunity to take a leadership position, the growing interest in aquaponics creates a competitive environment. The team has developed recommendations to help the City continue to advance its position.

A. Foster Growth of Aquaponics

Establish an Urban Agriculture and Aquaponics Council

Milwaukee is in the unique position of being at the center of a large concentration of public and private sector stakeholder expertise in the areas of water (the Milwaukee Water Council, the Great Lakes Water Institute, Milwaukee Water Works and Milwaukee Metropolitan Sewerage District), fresh water biology (University of Wisconsin Milwaukee (UWM) School of Freshwater Science), community urban agriculture (Growing Power and Walnut Way), public health (University of Wisconsin Madison School of Public Health), and research/higher education (UWM, Marquette University, Milwaukee School of Engineering (MSOE)). It is also home to emerging companies with a practical background in the aquaponics industry (Sweet Water Organics and Growing Power).

While there is a tremendous spirit of cooperation in the community, more formal coordination would benefit both the individual organizations and the “industry” as a whole. The team recommends that the City organize an Urban Agriculture and Aquaponics Council (Council), chartered with the mission of fostering the growth of aquaponics as an industry in the Milwaukee metropolitan area. This recommendation has been inspired by the success of the Milwaukee Water Council. Stakeholders would include the City, K12 and Higher Education, Research, Community Organizations, Health Organizations and companies or corporations such as those industry partners highlighted above.

The Council would serve as the mechanism to advance both the science and business success of the industry through the collaboration and sharing of knowledge, innovation, and technology. It would also serve to support and coordinate the outreach efforts of the urban agriculture community groups already underway.

Create an Aquaponics Innovation Center

The Council should create an Aquaponics Innovation Center. This Center would be a mechanism for collaboration and innovation to foster growth in the aquaponics industry. It would serve to identify, document, and quantify, where possible, best practices that can be replicated in new implementations. This Innovation Center would be a demonstration site to provide visibility of the aquaponics industry – to tell the story.

The Center would not replicate existing stakeholder functions but would seek to involve resources from the stakeholder members of the Council to aid research and collaboration. Its mission would include the following:

Facilitate Research/Industry Connections

The Innovation Center would facilitate laboratory and field research by providing the necessary link between private, public and university research sectors. Formal collaboration between stakeholders in the Milwaukee area and sharing of information on local implementation, operating and technology, would be more effective in advancing the opportunity for success in the industry. Examples would include investigating the viability of alternative fish species in aquaponics systems, based on geographic preference, reaction of fish growth to changes in environmental conditions and so forth.

Evaluate New Aquaponics Technologies

The Center would also evaluate new technologies, such as innovative sensors and metering, for introduction into aquaponics systems, and facilitate technology transfer and advise on issues of intellectual property. The Center would also work to identify sources of additional investment and funding through private investment or grant opportunities. This funding would be identified not only to support the growth of individual businesses but also the work of the Council.

Support Aquaponics Business Development and Maturity

Instrumentation is an opportunity for Milwaukee to further expand and exploit its technological leadership in the world. A number of the world's leading water-based sensor and instrumentation companies are located in the area. Currently, many aquaponic systems are created through a trial and error process with the achievement of an ideal balance for production quality, more art than science. Effective instrumentation will be a key driver in the standardization and wider adoption of aquaponic farming around the world.

With demonstrated success, aquaponics businesses will emerge in the Milwaukee metropolitan area and surrounding region. These businesses will become the source of valuable aquaponics industry data that can contribute to industry research and advancement, describing operating conditions and plant and fish yield data (for example as a function of environmental conditions). Without collaboration this vital data will remain in silos, used only for the benefit of an individual business. If the industry has the sharing of this data as its goal and objective, then it can be used to benefit aquaponics as a whole.

Sophisticated sensor networks, smart meters and analytics are making it possible to monitor, measure and analyze entire water ecosystems in real time. In aquaponics, tanks and systems must be continually monitored for temperature, pH levels, water quality, water levels, fish behavior, electrical failure, pipe blockages, pump effectiveness and other key data.

A series of “smart sensors” capable of measuring multiple parameters in tanks and along major points of an aquaponic system, will allow data collection of hundreds of different system conditions. Stream-computing software can be used to analyze complex acoustic data streams from fish as well as all other system data. Aquaponic farmers can then access the data directly, either at the farm or remotely via cell phones, from a real-time sensor data warehouse via a cloud-based information portal. Through instrumentation of the aquaponics process, farmers will be able to monitor a wide range of system conditions on a 24-7 basis, and then respond quickly to any critical challenges in the system if necessary.

The Innovation Center should be the focal point, to act as the data repository for data analysis, research and industry collaboration. Data associated with the operation of and research into aquaponics systems, including water quality (for example, dissolved oxygen, nitrogen levels), environmental conditions (such as water and air temperature), and fish/greens growth data, can be shared among the stakeholders to improve system operation and facilitate research in that area. Correlation between data parameters (for example, fish and greens growth versus water quality and environmental conditions) may also be studied to further optimize system operation.

As the aquaponics industry in Milwaukee evolves and matures, individual operations will expand. Additional instrumentation and analytics will be needed to monitor and control those factors of environment and system operation that are so critical to the success of aquaponics' product yield. Monitoring and control includes sensors, instrumentation, and supervisory control and data acquisition (SCADA) systems that can provide additional sources of data inputs for research and industry advancement.

The Center would provide the data collection and data analytics/optimization tools for analysis to the benefit all participants, in a shared services model that would distribute some of the costs of the system. Individual participating aquaponics businesses could take advantage of the instrumentation in their own facility by using the resulting data to optimize their own operations. This interconnection of data and higher level analysis across organizations would bring value to the overall industry. Thus, the value of the resulting whole would truly be greater than the sum of its individual parts. Examples of “collaboration platforms” in the water industry have already emerged, including work at Sonoma County Water Agency in California, and SmartBay in Ireland (IBM Journal of R&D, Hidaka et al.)

Act as a Business Incubator

The Center would provide business planning assistance to industry startup and developing companies. Both through physical and virtual connections, the Center could provide management mentorship and leadership skills development. The local Milwaukee business community might institute a “loaned executive program” or provide an executive coach to local aquaponics businesses. Loaned executives temporarily leave their existing jobs to mentor new business leaders or participate in periodic coaching sessions to develop business acumen. Area universities might also provide leadership development opportunities for the industry. As the industry matures and gains success, the local network would provide increasing peer support to the aquaponics industry in Milwaukee and beyond.

Investigate Operational Impacts on Aquaponics System Sustainability

Energy is one of the most significant operating costs of an aquaponics system. The Innovation Center would provide the means for disseminating and sharing information about energy-saving alternatives. For example, next generation low- energy lighting could be used to replace traditional lighting sources, saving power and reducing heat generation that could negatively affect plant production. In addition, the impact of locally produced and processed fish and produce on the fresh food supply chain would have a direct bearing on transportation costs, fuel savings, and the carbon footprint associated with food production.

Perform Public/Community Outreach and Information Dissemination

The Council would assist with the coordination of community outreach, supporting the work already underway by urban agriculture organizations. It would work to raise public awareness about aquaponics and the benefits of eating healthy, locally produced food.

It would also serve to support the work of community non-profit organizations that are focused on involving students and supporting K-12 education. It could leverage the work of organizations, such as Milwaukee Teacher Education Center (MTEC), which is currently building the science of aquaponics into the science, technology, engineering, and mathematics (STEM) curriculum.

B. Practical Implementation

Develop a Plan with Scheduled Checkpoints to Measure the Growth and Impact of the Industry

The team considered several possible locations for the Innovation Center, including the Reed Street Yards, where the Water Council and corridor are targeted, as well as locations near the Great Lakes Water Institute. However, the team kept returning to the themes discussed throughout this report, that urban agriculture and aquaponics have a positive impact on both industry development and community transformation. Aquaponics feeds many different aspects of a community.

With this in mind, the team saw the importance of locating the Aquaponics Innovation Center in an area of the city that would have potential for both industry development and community transformation. The City is already focusing planning and development efforts on the 30th Street Corridor and more specifically, Century City.

Using specific criteria around existing land use, vacant or under-utilized properties, transportation and access, site suitability, zoning, size of parcels and so on, the City has prioritized areas of focus for economic development. One example is the Century City project. In September, 2010, the City commissioned S.B. Friedman and Company to perform a land use study for Century City (City of Milwaukee 30th Street Corridor Land Use Study, September 15, 2010). The report identifies uses for the land as well as implementation factors.

As one of the City's first industrial development sites, Century City is symbolic of the rebirth of an area rich in city history and connected to Milwaukee's revitalization and innovation.

The team recommends that as an early task of the Urban Agriculture and Aquaponics Council, several members of the Council should collaborate with the City and neighborhood groups currently working on planning for the 30th Street Corridor, to add urban agriculture and aquaponics to the existing plan and create a model that could be used for future development efforts.

During the creation of this model, the Council, City and neighborhoods would be able to determine ways to leverage City programs and recommend areas of change to support both urban agriculture and aquaponics in Century City. Further involving these leaders in development and planning would (1) expand the discussions around economic development to include access to healthy food and choices, (2) identify additional ways to help build a community – a core, historical Milwaukee strength, and (3) initiate/establish the baseline spirit of collaboration that is the foundation for success.

Working separately, the City and its stakeholders have successfully transformed neighborhoods; working together, the synergies and opportunities for broader success become stronger and would create the basis for a model that could be replicated within and outside the city. In addition, a practical gap analysis could be created as a result of experience and lessons learned. This would help the City and its stakeholders in future economic development.

The creation of the Aquaponics Innovation Center would provide an ideal “laboratory” to explore how urban agriculture and aquaponics could be incorporated into the City's development process. We recommend considering the location of the Innovation Center in the A.O. Smith Research and Development Building (Building 65) in Century City. Locating the Innovation Center here could leverage existing investment in the building and draw in other potential commercial tenants.

The former A. O. Smith Headquarters Building (located next to Building 65) could also be a candidate for use as a community outreach and urban garden center, further tying urban agriculture and aquaponics to the surrounding neighborhood around Century City. While the Innovation Center could concentrate specifically on technology and research, the building next door could focus on community outreach and transformation.

Incorporating Technology

The implementation of an Innovation Center would validate the proposed use of technology through implementation and practice, and establish a critical core component of the industry infrastructure. The Center would accept data inputs from established aquaponics companies, such as Sweet Water Organics or Growing Power. Data would originate from existing sensors, SCADA systems, and laboratory analysis, if required. We recognize that at this stage of industry development, such instrumentation and sources of data may not fully exist. However, as the aquaponics systems mature and expand, instrumentation might be added and would be connected to the Innovation Center.

Collaboration, data aggregation, and analytics tools/software would be installed in the Center; the tools would be used for data analysis and visualization to facilitate overall aquaponics system evaluation and research. Such tools may be prohibitively expensive for implementation by each of the individual aquaponics businesses; the advantage of the Innovation Center is that as the incubator and data collection hub, it would install a single implementation of software tools and would make them available to the contributing aquaponics stakeholders as a shared service. In this way, important analytical tools that would otherwise be out of reach would then become available to industry stakeholders. If agreeable to the parties, aggregated data would also be available to the contributing stakeholders for their individual use. Lastly, work in the Innovation Center would become the seed for future work and collaboration in urban agriculture and aquaponics in Milwaukee.

Future Concept Expansion

As the proposed Century City model expands, additional aquaponics industry concepts could be incrementally added and evaluated. For example, the following initiatives might be incorporated into the aquaponics implementation model, with others developed as the project grows.

- **Incorporation of Food/Fish Processing Industries.**

The City could encourage food and fish processing companies to locate within the Corridor. This would be consistent with its goals of providing locally produced, healthy food to the surrounding community, while supporting community self-sustainability and reducing its industry carbon footprint. This would not only build a local focus, but it would also create jobs in the community, encourage development, establish an additional tax base for the City, and reduce the transportation costs associated with food delivery to the community. Furthermore, as aquaponics businesses mature and aspire to becoming vertically integrated, those companies may include food-processing as a part of their core businesses, with the same economic results. At the same time, vertical integration will add another dimension for study and research for the Innovation Center.

- **Community Outreach.** This model may be expanded over time to include outreach from the aquaponics businesses to the local community. Outreach may take the form of educating the community through healthy food classes, for example, or providing support for Milwaukee Public School (MPS) and local university curriculum, and programs such as the work performed by the Milwaukee Teacher Education Center (MTEC). It could also become a source of jobs for volunteers. As an example, Rufus King High School, which is located near the proposed location of the Innovation Center, is a source of student volunteers at Sweet Water Organics. As we have noted before, the secondary effects of this community outreach could result in reduced crime in surrounding areas and a strengthening of the fabric of neighborhood and family, as evidenced by work already done by Growing Power, Walnut Way, and Sweet Water Foundation.

Milwaukee as an Example for the World

Aquaponics has the potential to contribute significantly to Milwaukee's economic revitalization, not only by impacting the food supply of the city and its communities with locally-produced, healthy, fresh food but also through its positive contributions to education and neighborhood transformation.

At the same time, aquaponics holds tremendous promise for growth both inside and outside Milwaukee, in other locations in the Midwest, the rest of the United States and the world. Growth in aquaponics is not constrained to a particular geographical region. The mounting problem of inadequate global food supply, coupled with water availability and the effects of the supply chain, largely through transportation, on the earth's carbon footprint means that a worldwide need remains unfulfilled. Aquaponics' small fresh water footprint makes it an attractive solution for feeding water-stressed parts of the world, where availability of fresh food is a matter of daily survival.

In this global context and in Milwaukee itself, the viability of implementation and economic success of the aquaponics industry should be demonstrated, through incremental evaluation. The first priority is proven success in Milwaukee, followed by replication in other target American/international cities, with refinements through lessons learned. This should be followed by further expansion to other areas of the world as highlighted in Figure 4 below.

Evaluating Success

During this initial practical implementation, checkpoints should be established to validate incremental progress, analogous to project management milestones. These checkpoints provide rigor and process along two dimensions to minimize risk: (1) to validate technical implementation progress, for example, plant and fish health; environmental considerations such as water quality, including nitrogen and dissolved oxygen, the expansion of fish species, and facility expansion; and (2) to track economic and business progress, evaluating revenue and cost against the business plan.

If an implementation of aquaponics on a commercial scale can prove successful both technically and economically in one Milwaukee neighborhood, it can be replicated in others. It can also become the foundation of an urban aquaponics model to be used in other cities in the Midwest and across the USA and the world. Variations in model can be incorporated, based on the unique characteristics and requirements of each implementation. Refinements can be included as the experience base grows and lessons are learned. Documentation from this effort can become the basis for establishing Milwaukee as a global aquaponics center of competency for commercial implementation.

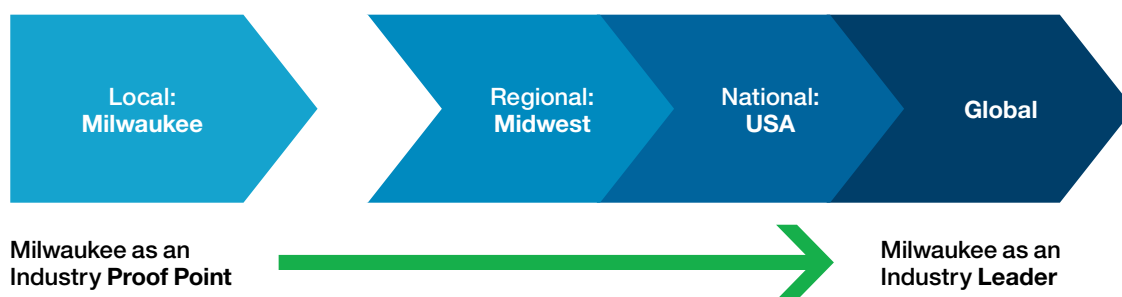


Figure 4
High Level Aquaponics Industry Roadmap

C. Develop an Assessment Strategy for Aquaponics

Professor Fred Binkowski, UWM Great Lakes Institute, has pioneered the field of aquaculture with a focus on freshwater fish farming. This has morphed into the aquaponics model for urban areas where land is scarce and vacant warehouses have been available for creative use. Environmentally-friendly aquaponics systems, where fish and greens create a closed loop water system for production, have been adopted by several Milwaukee organizations as well as other businesses throughout the world. This is a nascent “industry” where experimentation in production methodology, development of supply chains and market recognition is only in its infancy.

The City of Milwaukee has identified the need for better analysis not only of the market for aquaponics products, but also the cost-benefits of these businesses to the community. Better business information is needed at the individual business level as well as the overall aquaponics supply chain. Investments can be made at all levels, including the anticipated work of the Urban Agriculture and Aquaponics Council. To further the industry, it is important to assess where the greatest leverage can be achieved.

Milwaukee has both for-profit and not-for-profit aquaponics businesses, but at this early stage they are striving for sustainability. Rudimentary supply chains have emerged that include local suppliers of fish fingerlings (UWM Fresh Water Institute) and compost (Roundys), and in some instances, an intermediate food processor, before the products reach food stores and restaurants in the area. There appears to be neither a well-documented cost analysis of the aquaponics production model nor an economic analysis of the broader supply chain to create confidence for additional investments. To attract investment and create more jobs, it is necessary to greatly increase the scale of aquaponics operations and/or broaden the scope of those shared activities that create cost savings.

At this early stage of incubation, businesses including Sweet Water Organics and Growing Power have developed successful models of production, but need to grow to scale to be sustainable. In order to do this, far more data on the production cycles, water and energy consumption, productivity, and supply chain dynamics need to be documented, accumulated and benchmarked to build a community-wide profile of the industry. The cost per unit of a pound of fish or head of lettuce is understood at some level, but a more sophisticated analysis of the cost of inputs (labor, energy, seeds/fingerlings, water, land, food processing, transportation and distribution) must be undertaken to get a true picture of the operation. Today, volunteer labor is common in these operations; land use is subsidized or understated due to stress in warehouse real estate; and it is difficult to assess the actual operating costs and areas where investments can improve productivity and output.

As individual businesses operating at barely profitable levels, there is limited capacity to market products, develop management skills and improve production capacity. It is assumed that an Urban Agriculture and Aquaponics Council using the success of the Milwaukee Water Council as a model, would enable greater success. Since aquaponics food products today are not designated “organic”, which would attract a premium price, the Council could promote a “buy local” marketing strategy which could produce greater visibility and revenue along the entire supply chain. Better understanding of the marketplace would enable the City and other investors to determine where best to leverage their investments.

The team recommends that a formal market analysis and study be performed. The study should take a micro view of individual businesses as well as a broader market view to analyze the benefits of the aquaponics model against the more traditional vegetable and fish farms. It is believed that rising transportation costs and stress on fresh water supply could make aquaponics increasingly affordable and economically viable. This needs to be documented through case studies.

In Milwaukee, the aquaponics model has been deployed as part of neighborhood revitalization initiatives due to the location of these operations in underemployed areas of the city. Abundant anecdotal evidence is provided by various organizations citing benefits of youth volunteerism and employment, reduced crime, increased nutritious food supply in areas known as food deserts, hands-on learning opportunities in areas of science, technology and environment, and numerous other social benefits. At a minimum, it is recommended that these success stories be accumulated and catalogued in ways to build an industry view of the benefits of aquaponics businesses to Milwaukee.

The City, with its geographic information system (GIS) and other relevant data, has the opportunity to correlate this information against the location of these aquaponics organizations to get an initial view into how these positive impacts might be measured. Measuring intangibles is difficult and subjective, but if the benefits are compared with other City investment for neighborhoods such as parks and recreation, safety and so on, the opportunity to compare and contrast these investments might make aquaponics more meaningful or at minimum, competitive.

Beyond Milwaukee, in nearby Racine, in Indiana, Canada, Australia, and other urban centers, work in aquaponics is also underway. Models of maturing aquaponics businesses are emerging, but in the limited research performed during this study, there does not appear to be economic analysis of the marketplace – the supply chain, production statics and the rest. It appears that Milwaukee has every opportunity to bring business models and data analytics to the startup businesses in these places and to allow them to leapfrog to a more sustainable model. The team recommends that the City and the proposed Urban Agriculture and Aquaponics Council spend time focusing on whether the priority of aquaponics for Milwaukee lies in neighborhood investments or in developing a large industry model with expanded distribution beyond Milwaukee. In either case, the opportunity for Milwaukee to move from the local stage to that of a global player can be achieved. It is clear, however, that innovations in the field of aquaponics are accelerating in the U.S. and around the globe, in some cases in areas with greater need for ecologically-friendly production requiring less water.

Overall, it is critical for the City to determine the role it wishes to play and move decisively to confirm its role in aquaponics.

Workforce and Job Development

Understanding the potential for an industry would not be complete without a discussion around workforce and job creation. Milwaukee's deep rooted expertise in manufacturing has helped to create one of the most highly skilled manufacturing bases in the world. Location, work force and quality of life are the three biggest factors in attracting and keeping companies and residents in Milwaukee.

Our observation is that aquaponics itself, as an innovation in farming, may not be the largest supplier of jobs. However, we have determined that it is will become increasingly important to measure jobs throughout the aquaponics supply chain in order to truly understand the impact on the industry. While an aquaponics farm may only employ 40-50 people, if the industry can attract other businesses into the area, such as fish processors, a post-harvesting facility, as mentioned by Sharon Adams from Walnut Way, or a centrally located compost facility, as mentioned by Gretchen Mead from Victory Gardens, there is additional potential for jobs and economic development.

Understanding the impact of urban agriculture and aquaponics and its ability to fit within an economic model and feed additional jobs within the supply chain will become a key component in measuring the success of the industry.

D. Enhance City Programs and Policies

Milwaukee can continue its work to encourage development of the aquaponics business in the City through organizational enhancements, leveraging existing City systems and data, policy development, and use of City-implemented financing methods. These are described below and are intended to stimulate industry growth and success by removing City-influenced barriers where possible, and establishing an environment that fosters communication and collaboration between industry stakeholders – the aquaponics business, researchers and technical advisors, the urban agriculture community, and the City itself.

Organizational Enhancements

It is recommended that the role of the Milwaukee Office of Environmental Sustainability (OES) be expanded to include a role as the primary focal point within the City to encourage and support the formation of organizations such as the proposed Urban Agriculture and Aquaponics Council, described earlier. In this way, the City would be helping to formalize those pre-existing informal relationships, to stimulate progress and encourage faster success.

The OES would also act as a focus for the City to liaise with other organizations. It would coordinate and streamline access to the aquaponics businesses in relation to zoning and permitting. Another example might see the OES facilitating discussions between the aquaponics companies and outside organizations like We Energies, to encourage efficient use of energy in business operations.

Leverage Existing City Systems and Data

It is recommended that the City make maximum use of existing City applications and functions to support aquaponics business development. For example, City geographic information system (GIS) data is currently being collected and could be used to evaluate prime locations for aquaponics industry development by identifying the location of vacant property/land use correlated to neighborhood demographics, closest Milwaukee Public School (MPS) facility, neighborhood crime statistics, and other data.

Another example would include the existing citywide effort by the Division of Information and Technology Management to inventory and gather data as a means to provide better information and decision-making. This data could be used to encourage new aquaponics businesses to locate in Milwaukee and for existing businesses to operate more efficiently.

Policy Development

It is recommended that the City develop and advocate policies that nurture and support industry success and growth within the City's jurisdiction. These policies may take the following form:

- Low cost leases of City-owned property to stimulate start-up and growth of the aquaponics industry. Leases may be tied to ownership incentives, for example lease-to-ownership based on job creation. Lease awards by the City would require the development/submission of a comprehensive industry business plan. The City may further require that those awarded supply no-charge technical consulting to others in the industry to stimulate further development.
- Policies that encourage the development of new classes of business plans, justifications, and return-on-investment calculations. These should take into account encouraging/rewarding sustainability and documenting subjective, non-quantifiable community outreach factors that contribute to improvements in education, neighborhood revitalization, public safety, public health, and nutrition.
- Encouraging efforts by community groups to summarize and document existing industry stakeholder plans, programs, results, and recommendations. These should be in the form of summary reports, similar to that done for the City of Minneapolis, MN (Homegrown Minneapolis, Final Report Presented to the Health, Energy and Environment Committee of the Minneapolis City Council, June 15, 2009). The summary document would identify additional potential policies that might be required to support the aquaponics industry in the city.

Use of City-Implemented Financing Methods

Milwaukee is presently making use of Tax Increment Financing (TIF) and Water Attracting Valued Employers (WAVE) Rate methods to stimulate and encourage development of new industries in the City through financial incentives. Since aquaponics is a closed loop water system with minimal water use, the WAVE Economic Development Rate may not apply, but TIF may prove a viable financing alternative.

It is recommended that the City continue to investigate other creative uses of financing to stimulate industry development. We also recommend that business plans and models using inputs based on sustainability and social/community outreach be required when financing applications are submitted for evaluation and approval.

E. Funding/Cost Considerations

Governments are being asked to do more with less, so any potential investments or new programs that require funding must be carefully weighed and evaluated. Our recommendations have cost implications, so it is important for the City to be able to articulate their long-term public value. Starting with a more in-depth market analysis and the development of a process to measure social impact will help the City make these important trade-off decisions.

The innovative nature of aquaponics and its potential to address urban and global food issues, coupled with Milwaukee's acknowledged reputation as a leader in water research, management and innovation, together with its focus on sustainability, should open options for grant funding from a variety of sources, such as:

- National Science Foundation
- Housing and Urban Development
- Department of Energy
- U.S. Department of Agriculture.

5. Conclusion

The IBM team would like to extend its thanks and appreciation to the City of Milwaukee, Mayor Tom Barrett, Department of City Development Commissioner Rocky Marcoux, Senior Economic Development Specialist for the Redevelopment Authority Dan Casanova, the Milwaukee Water Council, Sweet Water Organics, Sweet Water Foundation, Growing Power, Walnut Way, the University of Wisconsin Milwaukee, the Water Institute, Natural Green Farms and everyone with whom we have had the pleasure of collaborating and interacting during the course of this study.

The question of how a smarter city feeds itself can be examined from several points of view. The first looks at providing convenient access to healthy food. Aquaponics as an extension of urban agriculture holds great promise as a sustainable solution, using less land than traditional agricultural methods. It also carries no significant fresh water requirements beyond initial start up. Local, urban production means that food travels fewer miles to go from “farm to fork”, saving transportation costs and having a positive impact on carbon footprint and the environment.

Feeding a city is more than just about food, however. It is also about feeding people metaphorically through job creation, neighborhood revitalization and public safety, providing outreach to the community, providing education on healthy eating, eliminating stretches of urban food deserts, giving vocational training to youth, stimulating innovation and technology, and supporting higher education and research. Aquaponics as an implementation of urban agriculture has the potential to address all of these social components.

However, more needs to be learned from aquaponics to make it work in a community. This study makes recommendations to evaluate the viability of aquaponics in Milwaukee. It also makes near-term recommendations to stimulate City and community involvement and to make formal those relationships that have to this point been informal. It recommends the initial formation of a specific governance structure, starting with the formation of the Urban Agriculture and Aquaponics Council, and the start up of an Aquaponics Innovation Center in the planned Century City development.

These recommendations are the starting points for Milwaukee to become a smarter city that feeds itself. By establishing local success and executing a roadmap plan that extends beyond the City to the rest of the world, Milwaukee has the potential to be in position to redefine itself both as a leader in water and in local food production.



6. Appendices

A1. Acknowledgements

A Smarter Cities Challenge grant is only as successful as its city's participation. We would like to thank the City of Milwaukee for hosting the IBM Smarter Cities Challenge team, all of the organizations that opened their doors and invited us to attend their meetings, and all of the individuals who modified their busy work schedules to see us. Your willingness to meet with us, answer our questions, embrace our team and openly discuss your challenges amazed us. We could not have completed our objectives without your hospitality, participation and insight.

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Dan Casanova, Sr. Economic Development Specialist

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Vanessa Koster, City of Milwaukee
Yves LaPierre, City of Milwaukee
Carrie Lewis, City of Milwaukee
Nancy Olson, City of Milwaukee
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Brennan Balestrieri, City of Milwaukee
Samer Abulughod, City of Milwaukee

We obtained additional perspectives from meetings with:

Fred Binkowski, Great Lakes Water Institute
Val Klump, Great Lakes Water Institute
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Dean Amhaus, Milwaukee Water Council
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Karen Sands, MMSD
Kymm Mutch, MPS
Tom McGinnity, MTEC
Joe Heineman, Natural Green Farms
Peter Forsberg, Northwestern Kellogg MBA Student
Glenn Ford, Praxis Marketplace
Steve Kinishi, Roundy's
Mark Harris, Shorewood High School
Emmanuel Pratt, Sweet Water Foundation
Josh Fraundorf, Sweet Water Organics
Matt Ray, Sweet Water Organics
James Godsil, Sweet Water Organics
Ralph Bencriscutto, Tower Energy Partners
Professor Sam White, UWM
Chancellor Michael Lovell, UWM
Gretchen Mead, Victory Gardens
Sharon Adams, Walnut Way
Michael Mervis, Zilber Family Foundation

A2. Team Profile

Stephanie Anderson

Stephanie Anderson is a Human Resources Partner for IBM. She is based in Chicago and supports 150 Managers and Executives throughout the Central Region of the United States, providing leadership, guidance and expertise on Human Resources issues and programs. Prior to becoming a Human Resources Partner, Stephanie managed a team of Consultants, IT Architects and Developers working on various projects and initiatives including several partnerships with non-profit companies, where IBM provided grants. Such projects included eternalegypt.org (a “virtual tour” through all of Egypt’s artifacts), a website for the Hermitage Museum in Russia and a handheld tour for MoMA in NYC.

Stephanie has also worked as a Project Manager and consultant on many other projects in her 15 years with IBM.

Prior to joining IBM, Stephanie worked for Manpower’s Headquarters in Milwaukee and also spent many years working at Summerfest and the ethnic festivals in Milwaukee. Stephanie grew up on the East Side of Milwaukee, but has lived in the Chicago area since 1988, when she attended Northwestern University. (She graduated in 1992.) Stephanie is married to Jay Anderson (also from Milwaukee, WI) and has three young children (ages nine, seven and four).

Sam LeSturgeon

Since January 2010, Sam has been a Smart City Sales Specialist focusing on smart water, building and grid solutions for US East public sector. Sam started with IBM in 1977 in the Office Products Division. In 1988 he became a Systems Engineer on the State of Indiana team. He became the lead sales executive covering Indiana State Government taking annual revenues from \$8M per year to \$150M per year.

In May of 2007 Sam focused on Indiana local government and closed a \$36M contract to integrate all technology at the new Indianapolis midfield terminal. In 2009 he learned how technology could manage the traffic in city sewers to save hundreds of millions of dollars. It was this finding and interest that led to his current role.

Sam lives in Indianapolis, Indiana where he and his wife Karen have raised three kids. Sam drives a Prius and finds time to bicycle and sail every weekend. In Boy Scout Troop 174 he runs the recycle program and enjoys his role as Advancement Chairman as the troop has four to fourteen scouts reaching the rank of Eagle each year.

As a Purdue engineering graduate, Sam enjoys applying common technology in uncommon ways to help save the planet one idea at a time.

Carey Hidaka, IBM Global Business Services

Carey is an IBM Public Sector Business Solutions Professional and certified consultant in Smarter Water Management business development. He has over 28 years of information technology experience and has practiced for nine years as a consulting environmental engineer and registered Professional Engineer (PE, State of Illinois). Here he focused on water resource planning and water/wastewater treatment plant designs and implementations for public and industrial sector clients. Carey holds a MBA with a specialization in finance from the University of Chicago, a MS in Environmental Engineering from the University of Illinois at Urbana-Champaign, and a BS in Civil Engineering (with honors) from the University of Colorado at Boulder. Carey has led Smarter Water projects for IBM in the U.S.A. and is a subject matter expert in the development of Smarter Water solutions as a part of IBM's Smarter Planet initiative.

Carey was born and raised in the Chicago metropolitan area and is third generation Japanese American (Sansei). He and his wife, Betsy, have been married for 33 years and have raised four children together. He enjoys fishing, golf, gardening, reading, and travel. He served on the Restoration Advisory Board for Naval Air Station Glenview as a community representative for matters involving environmental remediation, and volunteered as American Youth Soccer Organization (AYSO) soccer coach and park district baseball coach.

Sohaila Shomal

Sohaila is the Operations Manager for the IBM Water Management Centre of Excellence. She holds a BSc in Chemical Engineering from Southampton College of Technology UK and an MSc in Marine and Fuel Technology from Portsmouth University UK.

Sohaila worked for six years at the University of Limerick Ireland as lecturer in the Department of Industrial Chemistry. She led the development of Organic solvents and electrolytes to electro-chemical machine Titanium and stainless steel. In 1995 she joined a high volume hardware computer manufacturer in Dublin as a Production Manager. In 1998 she moved to IBM as Operations Manager in the microelectronics division of Integrated Supply Chain. She led the development of processes to improve production efficiency and reduce costs, resulting in annual saving of \$3.4 million. In 2003 she took a new role in IBM Server Manufacturing. Her key skills are in Strategic Planning, Economic Development, Performance Measurement, Change Management, Project/Program Management, Business Process Improvement and Leadership Development.

In 2009 Sohaila joined the Big Green Innovation global team to enable close collaboration with clients & water industry experts. She engaged with and built solutions to help all types of organizations solve water management problems worldwide by the better use of IT through pilot programs or full scale execution, using proven, tested and validated solutions & methodologies. Key projects in this domain were Smart Bay – Galway, a Sustainable City Visualization, a remote monitoring of raw water quality from catchment and lakes with an early warning system and integrated metering management network.

Sohaila is a member of the Women in Technology network, an Ireland-wide program that provides mentoring to women in technology.

Tracy Diaz

Tracy Diaz is a Client Executive working with local government and education clients in Texas. She has been with IBM for 22 years, during which time she has served in various roles, including account management, services sales, and sales management, all working within the Public Sector Organization.

Tracy holds an MBA from the Anderson Graduate School of Management at the University of New Mexico. Tracy is married and living in Austin, Texas, where she and her husband enjoy time with their family, including three grandchildren. She volunteers with the local Humane Society.

A3. References

Following is a list of related reference material that may be of value to understand the topics covered in this study.

1. IBM Institute for Business Value Study.

How to make your city smarter: Creating and assessing the path to prosperity

<http://www-935.ibm.com/services/us/gbs/bus/html/smarter-cities.html>

2. Smarter Cities for Smarter Growth – IBM Institute for Business Value

How cities can optimize their systems for the talent-based economy

http://www-05.ibm.com/ie/emerging_business_centre/pdf/SmarterCitiesforSmarterGrowth.pdf

3. The Milwaukee Water Council

<http://www.thewatercouncil.com>

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